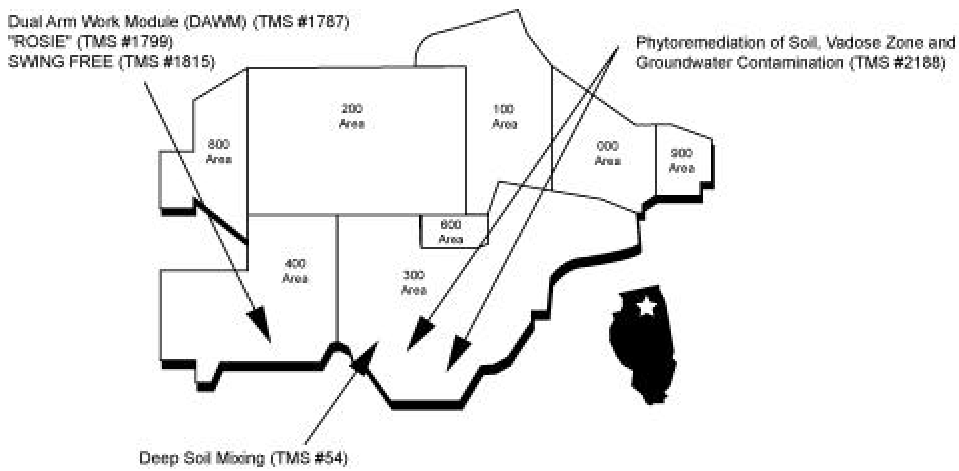
Significant S&T Activities at the Chicago Sites

March 2001

Argonne National Laboratory - East



Remediation of vadose zone and groundwater contamination
Several sites have relatively low concentrations of contaminants (but which are still of concern to regulators and stakeholders). **Phytoremediation of Soil, Vadose Zone and Groundwater Contamination** (TMS #2188) is the application of certain plant species (planting/growing/harvesting) that are known to uptake (in proportions higher than other species) certain contaminants from soil, vadose zone and groundwater. Deployment of this technology in June 1999 at **Argonne National Laboratory - East, French Drain Area 317 and 319**, gave an opportunity to determine the effectiveness of phytoremediation to remediate medium depth vadose zone and groundwater contamination. The process reduces the generation of secondary waste requiring treatment; rather than pump contaminated groundwater from wells and discharge to a facility for treatment, trees remove contaminants from groundwater and transpire water vapor into the atmosphere. Deployment of this technology in May 1999 at **Argonne National Laboratory - West**, provided an opportunity to determine the effectiveness of phytoremediation to remediate heavy metals in soils for removing low to moderate levels of metals (e.g., lead, cadmium and cesium) from large areas of surface soil. Technologies currently do not exist to economically remove heavy metals from large areas of contaminated surface soil.

Destruction of organic contaminants in low permeability soil
Volatile Organic Compounds (VOCs) (carbon tetrachloride, TCE, PCE and chloroform) are present at ANL-E in high-clay content glacial till. **Deep Soil Mixing** (TMS #54) is a soil treatment technique that can be used to destroy organic contaminants in this low permeability soil. The soil is mixed employing a dual auger system, while steam and hot air are being injected into the soil column. The steam and hot air carry the VOCs to the surface where they are captured on activated carbon. This reduces contaminant concentration from over 300 ppm to less than 10 ppm. The soil mixing equipment is also used to inject

metallic iron particles to treat residual VOC contaminants. A total of approximately 6,200 cubic yards will have been treated upon project completion by mid 1998.

Argonne National Laboratory-East CP-5 Reactor

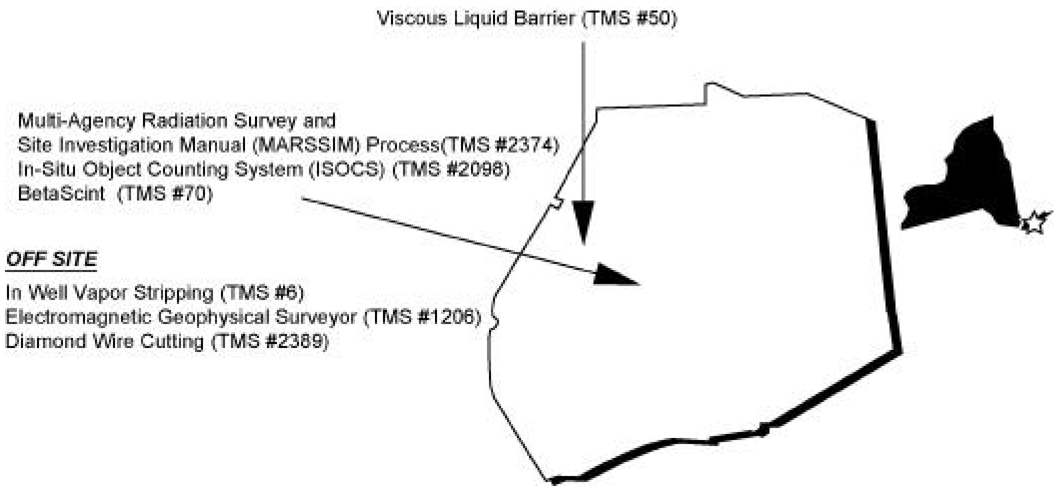
Remote handling and dismantlement of large, heavy, and highly radioactive components
A variety of Decommissioning and Dismantlement tasks at the CP-5 included reactor control rod cutting and sizing, reactor vessel dismantlement, removal of contaminated lead panels, and dismantlement and removal of graphite bricks from the control rod penetrations. The **Dual Arm Work Module** (DAWM) (TMS #1787) was developed by a consortium of national laboratories and industry manufacturers. The module houses various electrical and hydraulic systems needed to operate the two robotic manipulator arms and provides support for the tooling and end effectors. The module is designed to be suspended from a crane or mounted on an automated platform for remote positioning. The arms provide six-degrees-of-freedom and are powered by a 3,000-psi hydraulic system each capable of lifting 240 lbs. The DAWM was used from June-September, 1997 for remote handling and dismantlement of large, heavy, and highly radioactive components to eliminate worker exposure. Equipped with a circular saw, DAWM cut up large sections of the reactor and then passed them out to Rosie-C for size reduction and waste packaging.

Removal of contaminated graphite blocks and radioactive materials during D&D operations
Approximately 3,000 lbs of contaminated graphite blocks and 5,000 lbs of radioactive materials needed to be removed from the top of the CP-5 reactor without risking exposure to radiation by personnel. "**ROSIE"** (TMS #1799) was designed and implemented to deploy tooling for selective equipment removal and other decontamination and decommissioning tasks. ROSIE is designed to complement alternative manipulator gross positioning devices and can accommodate other robotics systems including the Dual Arm Work Module (DAWM). Rosie was designed and implemented from June to September 1997 to deploy tooling for selective equipment removal and other D&D tasks. In addition, a semi-automatic robotic perception system, called 'Artisan', was developed to analyze and generate a geometric model of the work system's surroundings. Rosie provides the capability to do remote work in a variety of D&D applications while Artisan provides capabilities that help Rosie operators perform tasks faster and safer. Rosie was used in conjunction with the DAWM and the Swing-Reduced Crane to conduct a number of dismantlement and waste disposition activities.

Removal of reactor shield plugs, graphite block shielding, and other reactor components
Precision operations such as deploying remotely operated equipment for dismantlement and size reduction tasks were needed during CP-5 reactor D&D operations. A crane was needed for lifts of critical loads, and during the placement of robotic dismantlement system in the CP-5 reactor structure. The **SWING FREE** (TMS #1815) technology consisting of swing-reduced control and remote crane upgrade project provided improvements to an existing polar crane at the CP-5 facility. The crane improvements and upgrades included a radio control system for remote operation of the crane, a motorized rotating block, an on-board remotely operated video camera, and load cells with remote load displays. This technology was demonstrated as part of the CP-5 Reactor Large Scale Demonstration Project from June to September 1997. ANL modified an existing overhead crane system by reducing the naturally induced crane swing. This crane system was used in conjunction with Rosie and DAWM to remove reactor shield plugs, graphite block shielding, and other reactor components. This system

provides more radiation protection to the worker than previously used manual operated long handled tools.

Brookhaven National Laboratory (BNL)



Alternative treatment of the groundwater for volatile organic contaminants
Several volatile organic compound contaminant plumes have migrated off-site at levels in excess of the drinking water standards causing much public concern. The traditional groundwater treatment approach, pump-and-treat, involves pumping the groundwater water from a series of extraction wells long distances to a treatment plant followed by discharge of the treated water to a recharge basin. In addition to the inconvenience of such an intrusive system to local residents and the large amount of land required, energy requirements are generally high due the large distances that the water would need to be moved. A series of seven wells were installed, and operation began at **BNL** in September 1999.

In Well Vapor Stripping (TMS #6) employs a combination of air-lift pumping and aeration within the borehole to strip volatile organic contaminants from the ground water. The water inside the wellbore is aerated by injecting air at the base of the wellbore, creating a turbulent frothing action. The rising air bubbles strip dissolved contaminants from the water and carry them in a vapor stream to the surface where they are treated. As an in-situ method, no aboveground handling of contaminated water is required. The process enables re-circulation of chemical aids (surfactants). Since the startup in December 1997, over 100 pounds of contaminants have been removed from the groundwater and over 80,000,000 gallons of water treated. The implementation of the in-well air stripping system has led to accelerated clean up, while helping to reduce public concerns over this plume. Cost savings are estimated to be about $2,000,000 compared to the baseline technology of pump-and-treat, and are mostly due to reduced energy requirements during the operation stage.

Characterization of the Brookhaven Graphite Research Reactor (BGRR)
Decontamination and decommissioning (D&D) of the Brookhaven Graphite Research Reactor (BGRR) requires extensive characterization of the ducts, equipment, and soil around the facility. Contaminant characterization is required prior to initiating D&D work for efficient and safe planning, during D&D activities to determine the proper disposition of waste materials, and post D&D to ensure that cleanup

levels are met. Traditional characterization approaches can be costly and time consuming and involve taking a large number of surveys and physical samples, sending them for analysis and evaluating the data. In addition, many of the areas requiring characterization are not readily accessible, or can lead to high radiation exposures to personnel. Implementation of the

Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) Process (TMS #2374) was implemented at BGRR from May to September 1999 using the **In-Situ Object Counting System (ISOCS)** (TMS #2098) and **BetaScint** (TMS #70) has substantial advantage over conventional approaches for radiological characterization of contaminated facilities that requires collecting and analyzing a large number of physical samples; for example, concrete borings and paint chips, and swipe samples from surfaces. Two state-of-the-art measurement technologies have been deployed to assist the characterization of the BGRR. These techniques provide a number of advantages compared with conventional characterization methods including near real-time data, ability to evaluate non-homogeneous materials, fewer samples required, and lower radiation dose exposure to personnel.

The In-Situ Object Counting System (ISOCS) can be operated as a mobile laboratory to quickly and inexpensively identify radioactivity in samples as well as measure radionuclides in place. ISOCS uses sophisticated computerized modeling to calibrate the device, evaluate specific physical conditions and quantify levels of radioactivity. Results are obtained in the field without having to wait for shipping and analyzing samples. Analyses can be conducted remotely, minimizing personnel exposure. This approach permits quick and accurate *in situ* analysis of complex contaminated facilities that previously would have required extensive time, effort and exposure of workers to characterize.

The BetaScint fiber optic sensor is specifically designed to detect and quantify Strontium-90, a radionuclide that was produced by the reactor, but cannot be detected by ISOCS or other gamma spectroscopy techniques. BetaScint is being deployed as a field laboratory that quickly, accurately and inexpensively detects concentrations of this radionuclide of concern. Use of these innovative characterization techniques reduces the number of conventional samples that must be taken, shipped and analyzed. Rapid results (minutes rather than weeks) allow real time decision making during fieldwork on items such as waste segregation and whether or not cleanup levels were met. Remote analyses improve health and safety by reducing worker radiation exposure. Cost savings result by reducing the number of samples that require off-site analysis, minimizing the volumes of waste that require off-site disposal and reducing personnel protection requirements. Elimination of thousands of samples alone can provide savings of over a million dollars. ISOCS and BetaScint are demonstrating improved data quality, resulting in lower risk to project personnel and to the public on completion of the decommissioning activity. These deployments at the BGRR are projected to save approximately $1.1 million over the estimated cost for BGRR characterization using the baseline approach of $4.8 million.

Treatment of contaminated soils

Medical isotopes are produced at the Brookhaven Linear Isotope Production (BLIP) facility by hitting a target with a high-energy proton beam. Some of the beam passes through the target and interacts with the soil surrounding the target producing radioactive compounds in a soil activation zone. This zone is located approximately 30 feet below grade and contains several radionuclides, including tritium and sodium-22, which have migrated to the groundwater.

The deployment in May 2000 of **Viscous Liquid Barrier** (TMS #50) used colloidal silica, as a viscous liquid, injected into the soils in the activation zone. The colloidal silica solidifies into a gel that forms a viscous liquid barrier that substantially reduces the potential for water flow through the contaminated region. Thus, this deployment protects the groundwater by minimizing the migration of contaminants (e.g. tritium) from the activation zone to the deeper soils and groundwater. Excavation of the contaminated soil is not possible due to the depth and nearby structures associated with the BLIP. The viscous liquid barrier technology allows the soil to be treated in place. The grouted soil will also serve as a beam stop to prevent additional soil activation.

Treatment of difficult waste streams

The **Sepradyne Thermal Desorption Process for Treatment of Mercury (TMS # 2380)** was applied to difficult to treat waste streams from the BNL Chemical Holes area, mercury mixed waste soils and mercury contaminated laboratory animal carcasses. Sepradyne is a vacuum-assisted thermal desorption process that has been demonstrated at multiple commercial facilities to effectively separate volatile metals and organics from waste matrices. The key to the effectiveness of the Sepradyne system is the proprietary rotary shaft seal that Raduce has developed. This allows very precise control of the vacuum and temperature levels in the process through all phases.

Accurate characterization for locating buried wastes

Electromagnetic Geophysical Surveyor (TMS #1206), an automated data acquisition system for collecting closely spaced magnetic data over large areas, was used in FY1995 to identify the location of buried waste objects. This technology was used to locate 50 pits, which had been used to dispose of laboratory wastes, chemical containers and animal carcasses. Results of the magnetic survey were fully consistent with findings of ground-penetrating radar and other electromagnetic surveys. The locations were defined with high accuracy. The data allowed better estimates of amounts of buried wastes compared to early estimates, as well as locating each pit for eventual excavation.

Waste Minimization during decommissioning and dismantlement at the BGRR

In any decommissioning and dismantlement (D&D) project, it is important to minimize the amount of radioactive waste that is generated for disposal. Often this can be done by carefully separating radioactive components and materials from those that are not contaminated and in some cases, removing radioactive materials from structural surfaces. Considering health and safety constraints, BNL was limited in the amount of on-site D&D treatment that could be accomplished for the very large reinforced concrete air ducts that cooled the BGRR. But with innovative planning, BNL devised a means to section and remove the structure, package it for safe transport, separate radioactive layers at an off-site treatment facility (thereby minimizing waste generated) and reduce the volume of the contaminated concrete. The BGRR air ducts were constructed of 9 in. thick reinforced concrete and segmentation of these radioactively contaminated ducts presents a significant challenge in the dismantlement and removal actions.

Diamond Wire Cutting (TMS #2389) is being deployed at BNL as part of this effort. This innovative technology is used to safely and efficiently cut through and section the air ducts for transport. Application of the Diamond Wire Saw has now allowed for the removal of sections of the BGRR air ducts (weighing up to 164,000 pounds). The cut-up sections of reinforced concrete duct are then tightly sealed to prevent leakage of radioactive contaminants and are shipped off-site to a licensed treatment facility. There, layers of radioactive contamination will be removed by application of the Tech X-Tract process, an innovative chemical and physical decontamination technology. The radioactive residuals will be collected, treated and disposed at a licensed disposal facility. Cleaned reinforced concrete will be buried in a conventional industrial landfill.

The Diamond Wire Saw is expected to reduce costs of BGRR air duct segmentation while significantly improving worker safety. Cutting is performed remotely, which reduces direct radiation exposure to workers and potential exposure from radionuclide particulates. Radioactive dust is suppressed and collected through a closed loop cooling water spray, thereby eliminating emissions to the environment. By careful removal and segregation of contaminants using the Diamond Wire Saw and the Tech X-Tract Process, the volume of waste generated will be minimized, thereby lowering costs by about $300,000 or 16% of the total project cost, while ensuring public health and safety.

Version 1